

## THE RIGHTS OF MAN AND THE WORLD WIDE WEB

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*La révolution du virtuel ne fait que commencer. Il s'agit d'un véritable 'cyber-bang' dont les conséquences économiques, culturelles, sociales, politiques sont incalculables. Je crois, en fait, que nous n'avons encore rien vu...La révolution actuelle est comparable, dans son essence, à la révolution de la Renaissance et de la Réforme...<sup>(1)</sup>*

This unrestrained opinion of the Internet merits attention in the context of the theme chosen by His Majesty for this meeting of the Academy. Several questions are evoked. Does the sudden appearance of a new world-linking highway of digital information mean the arrival of a new Enlightenment? How are we to tell an actual from a virtual revolution? While far from being a universal preoccupation, millions of persons are "browsing" daily on the World Wide Web<sup>(2)</sup>. Yet it remains a great boutique of vendors hawking goods, offering entertainment, with uncensored and unedited display. Will this untamed and highly commercial venture magically change the productivity, education and research of humankind?

### **The Negative.**

This "Web", which has come upon us so swiftly, is growing without control, with its ethic undefined. Anyone may paste up a "home page"; anyone may copy anything there. Standards are loose; no copyright is assured. Worse, global access to the Web is not equally shared. The basic infrastructure is in place in most countries, but is not functional in some, usually because of inadequate telephone and other equipment. The cost of equipment and charges for entry into most Web programs also remain prohibitively expensive to many. "Surfing on the Web," therefore, is low on the priorities of developing countries.

### **The Positive.**

Nevertheless, all over the world use of this global network is on the rise--in governments, in research, educational, and commercial institutions. Computer-literacy is now the entrance key to many kinds of employment. The twenty-first century will find most professionals, researchers, and many teachers bound to an umbilical computer-linkage, their productivity determined by connection to external sources of advice and direction. Urban and remote hospitals are becoming linked by the Web, and medical practice in isolation is no longer wise or acceptable. Research is no longer governed by the birth-rate of ideas but by the speed of flow of post-natal announcement. The Web has come to determine how knowledge is refined from ever-rising streams of information and how it is distributed to those whose productivity depends upon it.

### **The Existential Nature of Discovery.**

Discovery in most field has an existential nature. No invention or discovery exists before submission to peers by publication and after speedy dissemination to the wider scrutiny and consensus required for an admission to the realm of knowledge. The Net thus has become complementary to the sciences and education, because it can hold treasure houses of data that are collected, indexed and made universally available. For conveyance, the World Wide Web is the messenger of a greater Enlightenment.

**Medline.** The caches of data on Netline are many. The largest and most used index of medicine and biological research is **MEDLARS** (Medical Literature Analysis and Retrieval System run by the National Library of Medicine in Bethesda, Maryland<sup>(3)</sup>). Among the more than 30,000 periodicals published each year, about 4,000 are biomedical journals--more than half published outside the United States-- and which contain more than 400,000 citations (articles) per year. Within ten days of receipt each of these citations is indexed, and with its abstract, entered into the computerized data base **MEDLINE**, created in 1960. MEDLINE is the main root of some 40 separate computer data bases provided by the NLM in its MEDLARS. All told, these indexes now contain over 20 million bibliographic citations and abstracts.

By 1970, tapes containing the full MEDLINE data began to be distributed to **International MEDLARS Centers**, and thereafter up-dated regularly. Operators at each Center are trained to assist users in searching the data bases or carry out many searches themselves as a service. One month

ago, the leaders of the twenty-one MEDLARS Centers gathered in Washington for their biennial conferences. Hong Kong was the latest to sign the agreement of cooperation. Features of the home pages of the present Centers, along with their UNIVERSAL RESOURCE LOCATORS (URL's) by which they can be brought up on the Net appear on page "A" of the attached Appendix. Today Medline is available on-line at about half of U.S. medical schools, and nearly every student has a user codes permitting them access at will. Now over 100 different locations around the world have tape or on-line access to Medline, and many other sites use the indices on CD ROM discs. Last week a new version of MEDLINE or GRATEFUL MED for the Internet was released. This will permit users world wide to have access to the index directly from the server at the NLM.

**SEARCH.** This version of MEDLINE will be the most efficient and "user-friendly" yet among versions that have been made progressively more powerful and efficient by the development of cognitive and lexical systems based on construction of a **Universal Medical Language (UML)**. The center piece of this is a **Metathesaurus**, displaying the linguistic roots of terms in different languages. So far including French, German, Spanish and Portuguese, the Metathesaurus will continue to expand to cover other languages, and continue to integrate the clinical and research terminologies. The system of Medical subject headings (**MESH**) terms are constantly expanded to used to construct linkage of headings in tree-like or hierarchical fashion.

Using a "browser such as **Netscape**--the currently most popular one in use on the Web--searching the data in MEDLINE has become fast and efficient. Effective use of the WEB is based much on the use of **Hypertext Markup Language (HTML)** which is a feature of the Web, allowing specific words on the page of the browser to be activated by the touch of the computer's mouse. This permits automatic switching to other **MESH** headings or to different data bases as the object of the search is progressively and quickly localized through the ramifications of the MESH headings.

A simple example is shown on page "B" of the Appendix. Here Grateful Med was asked to find the titles and locations of the articles on the subject of leukemia written in French by our colleague Professor Jean Bernard, during the narrow period in the late 1960s. The search, yielding the titles of about ten articles was completed in approximately 30 seconds. Another click and the abstracts of selected articles were displayed.

The Browser allows graphic illustrations to be activated and enlarged, and the reviewer may capture a copy from the screen for his own use. All material on the page-or linked pages- may similarly be printed by the viewers own computer and stored in his files.

**USAGE.** An annual total of over seven million searches of MEDLINE are now done through the NLM's computer system alone. It is estimated that about 40 million are done worldwide. The capacity of the system at NLM, where 20,000 searches are made each day, illustrates the power of today's retrieval engines, which in turn will be greater tomorrow. Half of the searchers are health professionals. Presently 25 per cent of American physicians take advantage of the ability to search MEDLINE from their offices, homes, or patient bedside. Physicians have thus within their grasp far more information than anyone can memorize or find in any other way--knowledge assisting them to make the most correct diagnosis and treatment. Many testimonials have been made how ability to"Search has been life-saving.

### **TELEMEDICINE.**

The development of the use of the WEB for consultations, teaching sessions, the distant reading of pathology sections, electrocardiograms, radiograms, CAT-scans, MRI imaging and transfer of other data indicate that this will soon be a large part of the medicine of the future. The reduction of all data to digital form and its presentation on the Web places no limits on the sending of material for consultation and teaching purposes. In fact, the greatest limitation on the computerization and sharing of individual patient records remains the assurance of the protection of the privacy of the data. When this is problem is overcome, virtually all physician and hospital records will be available on the Internet for be used for consultative and billing purposes.

### **BIOMEDICAL RESEARCH**

**GENBANK.** Genbank is another NLM database. One of the largest collaborative biomedical studies in progress in the world today is the mapping of the human genome. More than 125,000 laboratories are participating and providing data to three centers of collection. The primary centers are at the **National Center for Biological Information** at the NLM; the European Biological Institute at Cambridge University, and the CBI at the National Institutes of Genetics in Tokyo. These three centers of data collection are painstakingly cataloging and indexing DNA sequences,

developing the full structure of each of the 100,000 human genes, and annotating their positions on the human chromosomes. Any worker around the world may push a button on the NETSCAPE home page of the National Center for Biotechnology Information at NIH and enter a fragment of DNA which will be rapidly compared with others in the index and classified. Allied tasks are the recording the protein products of their expression when they are learned, collection of mutations of single genes along with descriptions and comparison of the phenotypes of associated disease. The aim is assembly all these related pieces of information into the map of the genome of man, one of the most rapidly expanding data bases in the world. By agreement among all the participants, all of the data are freely accessible and exchanged on an up-to-date basis. At least 90 percent of all such human genetic data is estimated to be present. A small amount is kept from these data bases by commercial operations which regard it as proprietary information. Like the patenting of genes, the withholding of genetic information in this way is regarded in parts of Europe as a violation of Les Droits de l'Hommes. It is a position toward which many Americans are sympathetic.

A few features of the GENBANK or ENTREZ programs are illustrated in photographs from NETSCAPE displayed on page "C" in the Appendix. They include the structure of genes that can be called up by the viewer as data emerging from the DNA sequencer, the chromosomal location of gene clusters identified, and a listing of the diseases now known to be caused by abnormal genes including names of mutations. HTML is used to link information about given genes to the MEDLINE system for analysis and quick identification of articles in which the genes are featured. Soon, more and more of the journals from which the indexed citations come will themselves be published on disks or tapes. Thus with a few clicks of the mouse, one can see the structure of a gene, view the structure of its protein product, pursue the descriptions of chemical behavior and of phenotypic variation in the bearers of the different mutations, in the full texts of the authors who have made the original observations.

### **The Visible Human**

A striking example of the power of the new tools available for storing and manipulating data on the computer has recently been released by the National Library of Medicine. A man, condemned to capital punishment, dedicated his body to science. Radiograms, both standard and by computerized axial tomography, and magnetic resonance imaging were made

at intervals of one millimeter from head to toe. The imaging was repeated before the cadaver was sectioned by microtome and the images captured at the same intervals by digital photography. The data were then accessible to "electronic dissection", by which one can make spatial images of an organ or any parts of the body. A dramatic virtual image of such a computer dissection is presented in the photograph "D" in the Appendix, showing the relationships of the optic nerve to other structures<sup>(4)</sup>. One must keep in mind that the picture is achieved by mathematical manipulation of the photographic digital data base. Today, many schools have given up the teaching of anatomy. Teaching tools such as these will permit the revival of this subject in almost unlimited ways. One wonders what Albacutis or other great Arab surgeons would have thought of such electronic assistance for their healing art.

### **The Need for Infrastructure**

There are several troubling aspects of the unevenness with which peoples of the world are linked in such technology. One concern, expressed by many third world scientists, is the failure of the indices to admit their citations to the base. This is a reflection of the level of peer review considered adequate for admission of the citations. Recently UNESCO has been active in ways to explore this might be overcome.<sup>(5)</sup>

Lack of infrastructure (Web servers, adequate telephone service, and the computer equipment itself) is one of the most troubling aspect of this new technology to users. It is estimated that of many million connections to the Internet, only about 0.3 percent are in Latin America<sup>(6)</sup>, a fault laid to the fragile nature of the telephone system. It is hoped that more assistance for improved infrastructure will be extended by world-wide financial institutions, businesses and philanthropies. One recent example of such is the donation of millions of dollars by the Soros Foundation to make the Net available to research institutions in the Soviet Union.

The final page of the Appendix shows the geographical distribution of the 20 major centers to which the MEDLINE data base is distributed and up-dated regularly. From the Centers, some regional users are enabled to obtain the searches they need for their professional work, but access is uneven and sometimes expensive when commercial carriers are needed. Note that the Bireme/Paho center in Brazil acts as the axis for the continent of South America. Egypt and South Africa are presently the two centers in Africa. Now, of course, GRATEFUL MED is at last on the Web and its

availability will continue to rise. Where the Web and the Medline data bases are now accessible, health care is improving as a result. The capacity of a country to participate in sophisticated research, enhance its education and training to be more productive in modern industry is also related to its ability to participate in this "virtual revolution."

L'homme n'a de connaissance des choses naturelles que par les moyens de la correspondance avec ce qui tombe sous les sens<sup>(7)</sup>.

### NOTES

- (1) Philippe Quéu, in "Voyage dans la planète Cyber." L'Express. No. 2327 February 14, 1996.
- (2) The Internet is a communications system designed for transmitting digital data at very high speeds. Computers can access the Internet through telephone modem connections or directly through communications devices called "routers". Beginning in the 1960's the "net" was developed as an easier, informal communication between physicists, engineers, academics and other defense contractors. It offered electronic mail (email), access to other computers (telnet), and real-time exchange of files (f.t.p). Long-distance discussion groups (usenet) were added. Over the years the technology improved to permit faster transmission and receipt of large amounts of digital data, including graphics. Soon "browsers" capable of finding and displaying data at known locations on the network were devised. In the middle 1990s, a network developed on the Internet that came to be called the World Wide Web.
- (3) These include EMBASE, produced by Excerpta Medica, concentrating on European journals and those containing pharmacological citations; PASCAL (about 25% medical and 25% biology, rest science and technical) maintained by CNRS and available from servers of INSERM or DIMDI (Deutsche Institut für Medizinische Dokumentation); LILACS, which contains MEDLINE plus literature in Portuguese and Spanish, correlated by Bireme in Brazil; DATA-STAR, (Knight Ridder), CURRENT CONTENTS (Title citations only); ULRICH'S INTERNATIONAL PERIODICALS DIRECTORY; and many more. speciality directories, including the more than 40 maintained by NLM for cancer, AIDS, toxicology, bioethics, and other topics. The Institute of Information of the Chinese Academy of Medical Sciences has a data base of several hundred thousand citations in Chinese from the literature of both traditional and Western Chinese medicine.
- (4) This image has been derived in the Voxel project from Hamburg University, using the Visual Human data base.
- (5) Gibbs, Wayt.. Lost Science in the Third World. Scientific American, August, 1995, 92-99.
- (6) Casari, Adolfo. Internet or Internot. The Internet May/June 1995, 29-31.
- (7) René Descartes. Cogitationes privatae.